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ABSTRACT

This document reports on a planning conference of the International Mathematics Committee, responsible for the second study of school mathematics to be conducted by the International Association for the Evaluation of Educational Achievement (IEA). The study will address issues of interest to mathematics educators, with emphasis on the areas of curricula, classroom processes, and comparisons with performance in the first IEA mathematics study. Three phases are envisaged: planning, now underway; data collection, in 1978-79; and data analysis, interpretation, and dissemination, in 1978-81. Questions to be addressed, instrumentation, and procedures for conducting the study are discussed. Appended is a list of teacher, school, and student variables to be considered, plus a detailed tentative timetable. (MS)

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International Study of Mathematics Achievement: Planning Conference

Final Report

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Note: This document, while a final report to the National Institute of Education under the terms of its grant, is not to be taken as a definitive statement concerning the Second IEA Mathematics Study. It is intended, rather, as a communication which outlines various aspects of the study, and serves as a basis for discussion for interested parties. Further informations may be obtained from:

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FINAL REPORT

International Study of Mathematics Achievement: Planning Conference

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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November 30, 1976

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Abstract

In the early 1960's, the International Association for the Evaluation of Educational Achievement (IEA) conducted a survey of mathematics achievement in the schools of twelve countries (Husen, T. International Study of Achievement in Mathematics, 2 vols., New York: Wiley, 1967). Later in that decade, surveys in other school subjects were conducted, in approximately 20 countries. Early in this decade, IEA became interested in a second round of surveys and in 1974 decided to conduct a second study of school mathematics. Substantive planning for this second study was done at the conference as reported herein, and has continued at subsequent meetings of the International Mathematics Committee, the group which has primary responsibility for the study. The study will address issues of interest to mathematics educators, and will cluster around the areas of curriculums, classroom processes and comparisons with performance in the first mathematics study. Three phases of the study are envisaged: Phase I, Planning, which is now underway; Phase II, Data Collection, in 1978-1979 and Phase III, Data Analysis, Interpertation and Dissemination of Findings, which will comprise the period 1978-1981.

A Second International Survey of School Mathematics

I. Introduction

During the 1960's, the International Association for the Evaluation of Educational Achievement (IEA) conducted a series of cross-national surveys in education. These studies involved some twenty-three nations and covered such subjects as mathematics, reading, science, literature, civic education, English as a foreign language and French as a foreign language. Student achievement in these subjects was examined in the light of the home background of students, school organization, curriculum, and other cultural and educational variables.

The mathematics study, the first to be completed, was conducted in 1963-1964 (Husen, T. International Study of Achievement in Mathematics, 2 vols., Stockholm and New York, Almqvist and Wiksell and John Wiley, 1967). This pioneering effort in international evaluation provided an array of baseline data in mathematics education at an early point in the curriculum reform movement. Since the early 1960s, curriculum reform has been widespread, with many IEA countries launching their own curriculum development projects. As a result, topics described loosely as those in "new mathematics" have been introduced and emphases on topics remaining in the curriculum have changed. In some countries dramatic changeovers have been made from selective to comprehensive systems of education, with consequent changes in the makeup of students in the populations studying the various curriculums. In many countries, the proportion of an age group continuing in school until the pre-university year has increased substantially. Other developments, such as the rapid increase in the availability of the hand-held calculator and the conversion to SI measurement, have also taken place in the past decade. Each of these changes is likely to have had repercussions on the mathematical outcomes, both cognitive and affective, for the two populations of major concern to IEA: thirteen year olds and students in their final

year of high school who are specializing in mathematics. There is considerable debate in some quarters as to the nature and extent of such shifts, but a portrait of the actual situation can best be drawn from a study of the type proposed by IEA. Furthermore, since the modifications have occurred to different extents in different countries, the international character of the project will help in disentangling the various factors involved in such changes in curriculum and student performance.

The numerous issues fostered by the past two decade of mathematics curriculum innovation throughout the world have created a current volatility in mathematics education. There is uncertainty about the value of new curricula, questioning of the success of the curriculum and of classrooms processes in producing usable skills, and debate on the probable (and proper) impact of modern technology (e.g., computers and calculators) on the future of mathematics teaching, mathematics curricula, and mathematics teacher education. It is imperative that information be systematically gathered on these issues at this time in order to provide benchmark data for the fifteen years since the first international mathematics study, to help resolve current problems in mathematics education and to provide a second benchmark against which future developments can be compared.

The second IEA mathematics study will be designed to provide needed input for decision makers at national, regional and local levels. The study will focus upon those issues of primary interest to mathematics educators for which an international perspective can supplement those perspectives obtained at national and lower levels. While some countries have already completed or are presently involved in their own national surveys, there are compelling reasons why an international survey should be conducted at this point in time. Individual countries can learn from each other, from successes as well as from failures. The diversity between countries can provide opportunities to examine educational

practices which may be relatively uniform within countries. Also, the resulting international contacts can foster a healty examination of educational practice within countries. Furthermore, past experience has shown that the conducting of an IEA survey can contribute toward the training of cadres evaluation experts in participating countries and stimulate interest in sub-investigations utilizing the survey data as well as in independent national surveys which address issues raised by the IEA studies themselves.

II. Issues

The second IEA mathematics survey will be designed to address issues in the following areas: the mathematics curriculum; classroom processes; and changes in mathematics education since 1964, the date of the first IEA mathematics survey.

A. The mathematics curriculum

The survey will provide an international perspective on what mathematics is being taught in schools, the relative importance attached to the various content areas and cognitive behaviors, and the extent to which differing views on the nature of mathematics (for example, pure versus applied emphases) are reflected in the nature of the curriculum. The analysis will include a study of intended curriculums (syllabi, textbooks, national or regional examinations) and implemented curriculums (teacher and student reports on actual exposure to various topics in the curriculum). The following aspects of curriculum analyses are of primary interest: (1) What is the nature of the curriculum? (2) What is the role of applications in the curriculums of the various countries? and (3) What common core or "kernel" of minimal competencies exists between countries?

1. Nature of the curriculum

Issue: What mathematics topics comprise the curriculum and what levels

of cognitive behavior are emphasized for each topic? The curriculum analysis will be based upon a content behaviors grid, in which the four levels of behavior are computation, comprehension, application and analysis, and the categories for content will include the following (see Appendix B for further details):

a) arithmetic (13 year olds)

b) algebra

c) geometry

d) probability and statistics

e) measurement

f) sets, relations and functions (pre-University)

g) number systems (pre-University)

h) analysis (pre-University)

i) finite mathematics (pre-University)

j) computer science (pre-University)

k) logic (pre-University)

l) history of mathematics (pre-University)

i) Rationale: In current considerations concerning the content and organization of school mathematics programs, the above topics have been the focus of discussion and experimentation. Considerable cross-national variation in the treatment of each topic is expected to be found and the likelihood is great that a curriculum analysis will provide needed information concerning the relationships between curricular emphases and student outcomes (both cognitive and affective.)

ii) Modus Operandi: The required information is primarily descriptive though several topics will undoubtedly be the subject of interesting correlational analysis. For example, performance on the geometry

sub-test can be associated with various innovative approaches in national curriculums.

iii) Instrumentation: The data for these questions are to be collected through questionnaires at the national and local levels and supplemented by "opportunity to learn" measures obtained, it is hoped, from both teachers and students. As the opportunity to learn measures are developed, it is essential that careful development and validation be done in order to obtain as accurate an assessment as possible of what is being taught in IEA classrooms.

iv) Analysis: The information required here will comprise a picture of the mathematics curriculum from a broad international perspective. The findings may thus be reported in an expository form, accompanied by context behaviors grids. The assistance of mathematics curriculum experts with deep knowledge of the various national school systems will be essential.

2. The Role of Applications

Issue: What is the role of applications in the mathematics curriculum?

i) Rationale: There has been an increasing concern over the perceived relevance of mathematics in todays society, with a corresponding increase in the importance of applications of mathematics in the curriculum. Applications can be present in the curriculum in a variety of ways. They can be used mainly to introduce or illustrate mathematical ideas which have been developed according to the logical structure of mathematics. Applications can be introduced by a co-ordination of the scope and sequence of the mathematics curriculum with the science curriculum or, the school curriculum can be organized around broad interdisciplinary problems (applications) with mathematics developing incidentally. The extent and impact on interest,

attitude, understanding, and problem solving ability of each of these approaches is unknown. The variability in curriculum practices across countries may offer some insight into the possibilities as well as their effectiveness.

ii) Modus Operandi: The data collected will primarily be descriptive. However, post hoc consideration of the correlation of certain discernible patterns of achievement and attitude might be undertaken.

iii) Instrumentation: Teacher questionnaires should be carefully formulated to assess the extent and treatment of applications in the classroom. Both how applications are presented and time allotted are of interest. Information from the students regarding their perceptions of the utility of mathematics might also be obtained.

iv) Analysis: An expository presentation of the data with possible post hoc correlational analysis of identifiable trends with certain achievement subscores and affective outcomes.

3. Minimal Competencies

Issue: What minimal mathematical competencies for functional citizenship are specified as goals by each IEA country and to what extent are such goals attained?

i) Rationale: The curriculum reform movement of the 1960's has left in its wake a renewed concern for basic mathematical skills. Some schools, for example, now require students to pass an exit test of minimal skills before allowing them to graduate from secondary schools. The extent to which IEA countries have developed specifications of minimal competencies, the nature of these competencies and the extent to which these competencies (or a core of these competencies) is possessed by students in the various countries will provide useful information for those looking for ways to aid children in obtaining the skills necessary for functioning in society.

ii) Modus Operandi: This issue will be addressed primarily by descriptive data. National centers will be asked to provide copies of statements (if they exist) concerning minimal mathematical competencies which have been developed in their countries. The national centers will also be asked to respond to an open-ended questionnaire concerning their countries goals for minimal mathematical competencies. Test data (item and sub-score) will be used to describe levels of performance of the students in the IEA samples in selected areas of mathematical competence.

iii) Instrumentation: Questionnaires, curriculum analysis and tests will be employed.

iv) Analysis: Item and sub-score data will be presented for both the first and second IEA mathematics studies. Profiles displaying areas of mathematical competence expected by each country and corresponding performance levels of students together with a composi international profile will be prepared.

B. Classroom Processes

The survey will attempt to portray, in as detailed a manner as is possible, the nature of the ongoing processes in mathematics classrooms in IEA countries. These classroom processes include the teaching strategies which are employed (lecturing, using small group discussion, doing class or individual projects, individualizing instruction, and so on), the emphasis (expressed in terms of amount of time spent) placed on various mathematical topics and the extent to which students are actively involved in the mathematics lesson.

1. Teaching Strategies

Issue: What do teachers do in mathematics classrooms and what is the relationship between what is done and student outcomes (both cognitive and affective)?

i) Rationale: If it is assumed that the major part of learning school-level mathematics takes place in the classroom, then a study of classroom processes and their relation to achievement and attitudes takes on great importance. Among these classroom processes are:

a) the planning of the lesson

b) allocation of teacher time to various class activies

c) use of group methods of instruction

d) the extent to which student cooperation is encouraged

e) the extent to which teachers allow for individual differences in rates of student teaching

f) the types of instructional material used

g) the use of homework assignments (length, type, etc.)

h) methods of evaluating student progress

It is expected that the resulting information will be of interst to classroom teachers, teacher educators and, in some countries, to educational policy makers. Since classroom processes within some countries may tend to be relatively homogeneous, between countries analyses may be most successful in explaining variance in cognitive and affective outcomes.

ii) Modus Operandi: Use of teacher and student questionnaires will be made. Both descriptive and correlational statistics will be of interst.

iii) Instrumentation: The most direct and reliable source of most of the data required is that of classroom observation. However, in an international study of this magnitude, classroom observations are not feasible. The most suitable alternative to direct observation appears to be the use of teacher and student questionnaires. These instrumentations must be carefully constructed and validated in the participating countries.

iv) Analysis: A description of classroom processes typically taking place in the schools of IEA countries would be of interest to teachers of mathematics. Correlations would also be found between the various classroom process variables and the cognitive and affective outcomes.

2. Exposure to Instruction

Issue: Is there a relationship between the mathematics outcomes, both cognitive and affective, and exposure to mathematics instruction as measured by

a) number of hours per week in school

b) number of hours per week in mathematics

c) number of weeks in school year

d) percentage of students in daily attendance

i) Rationale: It is suspected that there is a relationship between total time allotted to mathematics instruction and mathematical outcomes. The variability across countries might offer some insight into the influence of exposure to mathematics on mathematics achievement and attitudes.

ii) Modus Operandi: The question is primarily correlational. However, descriptive information concerning the amount and variability of time allotted to mathematics both within and between countries is of interest.

iii) Instrumentation: Questionnaires focussing on the number of hours allotted to mathematics should be carefully constructed. The validity of the responses might be checked by comparison with teacher logs or selected classroom observations.

iv) Analysis: Correlational analysis of time allotments with mathematics achievement score and subscores and with affective measures should be undertaken as well as descriptive presentation of the amount and

variability of time allotted to mathematics instruction within each country.

C. Changes in Mathematics Education Since 1964

For many IEA countries, a major concern is the comparison of the status of mathematics education now with the status 15 years ago. This information is needed by decision-makers who will help determine future directions on the basis of outcomes of changes in these last 15 years.

1. Benchmark Comparisons

Issue: What changes have occurred in mathematics education (curriculum, achievements, attitudes, classroom processes, school organization) from 1964 to present?

i) Rationale: Although marked changes in mathematics education have taken place in the last decade and a half, there is little hard evidence to document the extent and magnitude of these changes from an international perspective. . Evidence based on "anchor material" from the first survey combined with evidence from the second survey will provide a data base for describing these changes and exploring relationships between these changes and student outcomes.

ii) Modus Operandi: This is primarily a descriptive task. Information is to be gathered from national centers, teachers, and students in order to ascertain the nature and extent of changes in mathematics education. One important facet of such an investigation is that of the direction and magnitude of score differences (both cognitive and affective). There are numerous variables which might help explain score differences. But since many of these will not be measured in this survey, strong arguments for cause and effect can not be made. The consistency or inconsistency of such differences interpeted across

countries and subgroups (e.g., sex, age, amount of mathematics studied) may indicate, however, that certain explanations are more plausible than others.

iii) Instrumentation: The description to be made depends first upon including in the second survey appropriate anchor material from the first survey. But the anchor material must be supplemented with materials designed to provide information about changes during the interim period. In the first case, instruments must be reviewed for clarity and ease of interpretation and be justified for use in the second survey. In the second, questions must be generated to ascertain the nature of changes in mathematics education. Cognitive and affective instruments should contain items which focus both on what exists now and what has happened since the first survey.

iv) Analysis: What is desired is a broad international portrait of changes in mathematics education. The focus is on trends in curriculum, classroom processes, and student outcomes. Profiles of the direction and magnitude of score differences should be made. Similarities and dispartties in the profiles should be highlighted and interpreted.

2. Sex Differences

Issue: How is gender related to the cognitive and affective outcomes?

i) Rationale: It is generally agreed that there are differences in mathematics achievement by sex. Given the changing role of women in many societies, then, the variability of those differences across cultures is of particular interest as are the differences from 1964 to 1977 in those countries where the role of women has been emerging.

ii) Modus Operandi: The required information is primarily descriptive although statistical analysis will be necessary to measure the significance of the difference both between sexes, across countries by sex, and between the first and second survey by sex.

iii) Instrumentation: The sex of each student must be identified.

iv) Analysis: Exposition of findings. Interpretations of any observed sex differences in light of existing or changing social pattern is not within the scope of the study.

3. Uses of Hand-held Calculators

Issue: What is the extent and impact of the use of hand-held calculators on

1) methods of teaching mathematics?

2) nature of the curriculum?

3) mathematical outcomes, both cognitive and affective?

i) Rationale: Technological developments within the past five years have made possible astounding advances in the capability, availability and economic feasibility of hand calculators. The implications of this development for the teaching and learning of mathematics, while appearing to be profound, are to date virtually unknown. Several countries are making extensive use of hand calculators in schools while others are, at present, making little use of them. This variability can provide the opportunity to explain variations in classroom processes and outcomes.

Some questions are:

a) What is the extent of current use of calculators (length of time they have been used in the classroom, and frequency of use at present?

b) what is the relationship between use of calculators and arithmetic computational skills

algebraic manipulative skills (factoring, etc.)

problem-solving abilities

attitudes toward mathematics

c) To what extent does availability of a hand calculator have an impact on a country's views as to the basic mathematical competencies in that country?

d) What is the degree of acceptance of the hand calculator on the part of administrators, teachers, students, and their parents (as reported by the students)?

ii) Modus Operandi: An important aspect of the research relative to this issue will consist of describing current patterns of usage as reported by the national centers. However, a correlational study will also be conducted in an attempt to account for variation in outcomes by the hand calculator variables. Assuming that the cognitive test will be administered in two sessions, we recommend that calculators not be used for responding to the session I test, and that calculators be permitted during session II. Furthermore, those students electing to use a calculator during session II, will be asked to indicate for each item whether or not a calculator was used in responding to that item (an additional box to check on the answer sheet is envisioned). Finally, all students who use a calculator in school (regardless of whether they use one for taking the IEA test) will be asked to complete a short questionnaire reporting on their attitudes towards and uses of hand calculators.

iii) Instrumentation: Items to be developed for

Pupil questionnaire (Appendix F, items 48-53)

Teacher questionnaire (Appendix E, items 35, 38)

School questionnaire (Appendix D, items 42-45)

iv) Analysis: The proposed design will enable such analyses as

a) extent of use of calculators in mathematics class

b) kinds of mathematical tasks for which students seek calculator assistance (routine calculation, extracting roots, solving equations, etc.)

c) comparison of performance on parallel forms with and without calculators

d) comparison with 1964 benchmark with and with calculators

e) relations between extent of use of calculators and mathematical competence

f) relations between kind of use of calculators and mathematical competence

The analysis should also permit a comparison of different strategies used in mathematics classes. For example, certain items, as the square root of 12.75, will be solved differently without a calculator, with a calculator having a square root key and with a calculator not having a square root key. It will also be possible to determine the extent to which they choose to use the calculator on the test (with this usage related to kind of calculator, experience with a calculator, teacher acceptance of calculators, and so on).

4. Conversion to SI Measurement (International Option)

Issue: What is the extent and impact of conversion to SI measurement on mathematics curricula of the schools?

i) Rationale: In the 11 years since the first mathematics study, several IEA countries have initiated and nearly completed conversion to the metric system of measurement. The United States has begun on such a conversion and can gain considerable insight into the problems associated with and implications of this change.

ii) Modus Operandi: Survey and inspection of certain achievement sub-scores.

iii) Instrumentation: The picture of "metric" impact on curricula should emerge from broad surveys at national and local levels (opportunity to learn being a critical factor), though special questions of metric impact should probably be addressed to the United Kingdom, Australia, the United States, and Canada. Also, achievement tests should include appropriate items to test general understanding of measurement principles and special SI concepts.

iv) Analysis: Survey reporting in explository style, indicating extent of metric treatment in curriculum, and post hoc interpretive correlations.

III. Instrumentation

A major activity of the IEA International Committee on Mathematics during the planning phase will be the development and validation of the various information gathering instruments for use in the study. These include a curriculum survey utilizing open ended responses; a content behaviors grid; questionnaires for national center; schools, teachers, and students to provide information and descriptive data; achievement tests; a measure of verbal ability; and attitude scales. Information on national examinations will also be sought.

All instruments will need to be subjected to two sorts of validation. In the first case, the instruments will be validated conceptually. That is, as part of the development process, the instruments will be cycled through field trial, supportive information from national centers, revision, and review cycles to provide assurance that the desired measures are being obtained. Secondly, each instrument will be subjected to cross-national validation.

The internal validation studies of instruments will depend on the nature of the instrument. For example, the opportunity to learn variables will be measured by a questionnaire and internal validity studies will include interviews will field-trial teachers and their students to verify in fact that the instrument obtains an index of the actual curriculum coverage of a topic. On the other hand, the achievement scales will be closely evaluated for content validity. The construct validity of the attitude scales will be a serious concern and the necessary field trials will be done to determine this validity.

The cross-national validation involves the extended trials of the instruments in various countries and includes the vigorous use of translation and back-translation of text to assure that the instruments are comparable in countries where different cultures and languages must be taken into account.

The development of instruments follows from the delineation of issues in mathematics education for which an international perspective would be useful. The posing of the significant questions or issues is the first step this was begun at Urbana and continued at St. Andrews. Then, the information and measures can be specified. Once the desired information and measures are known, then development of instruments to obtain the information and the measures can proceed. An important point-of-view in this study is that the significant questions to be addressed determine what information and measures will be obtained and what analysis will be employed.

A. Curriculum Surveys

Many of the questions in this study will necessitate the analysis and contrast of mathematics curricula and classroom procedures. Therefore curriculum surveys by open-end questions and by detailed questionnaires will be obtained from each participating country though its national center. At the Urbana Conference and at the St. Andrews Conference, mathematicians, mathematics educators and measurement specialists have produced a detailed outline of content and

behavioral levels. Thus, a content X behaviors grid with detailed description of categories in each dimension and example items has been prepared as a frame of reference document. Each participating country will be asked to analyze its mathematics curriculum in terms of this grid, responding by 1) coverage of the various categories, 2) example items for assessing the categories in their countries, 3) example items for assessing specific questions and categorizing the items by the grid, and 4) response to open-end questions about the curriculum. The curriculum survey information is essential to final selection of instruments for data gathering later in the study. The reports of these curriculum analysis are a major product of the second IEA mathematics study.

B. Achievement Measures

The content X behaviors grid and the major questions of the study will be used to specify the mathematics achievement items. Approximately 1 hour of pre-test and hours of posttest will be identified for mathematics topics. A core of test items will be given to all students to measure performance where correlates of achievement are of interest. Some items will be readministered from the 1964 study to provide measures of change. Some use will be made of item sampling techniques to measure performance on items where level of achievement is the primary question. Suggested items will be obtained from the national centers, analysized in terms of the grid, subjected to field trial, subjected to cross-national validation and final selection performed by the international committee.

C. Attitude Measures

The Urbana Conference and the St. Andrews Conference have generated considerable interest in obtaining measures of attitude in the study. There is agreement that the measures be primarily content (mathematics) specific rather than general. Four attitude domains have been discussed. 1) attitude toward mathematics in school; 2) attitude toward mathematics in society; 3) attitude toward mathematics

as a discipline, and 4) attitude toward mathematics and self. Reviews of available mathematics attitude scales are being pursued by the International Committee in coordination with the IEA staff, and the USA National Assessment (NAEP). A comprehensive field trial of items and scales for each of the four attitude domains will be pursued by NAEP. The results of this preliminary work will be utilized by the IEA International Mathematics Committee to select potential items.

D. Questionnaires and Descriptive Scales

Much of the information of interest to the second IEA mathematics study is descriptive and will be obtained by questionnaires directed to national centers, schools, teachers, or students. Some of these questionnaires will be adapted from presently available instruments. Some will be determined by the focal questions of the study; others will be determined by the results of the curriculum survey. In each case the internal and cross-national validations will be pursued to the extent needed for unambiguous reliable information.

E. A Measure of Verbal Ability

The considerable literature on the role of verbal ability in academic performance suggests that such a measure be considered as a predictor variable in the second IEA mathematics study. Scales previously used in IEA studies will be considered as well as other alternatives.

IV. Procedures

If issues of primary concern to mathematics educators are to be effectively addressed by a second IEA survey, then it is imperative that the design of the study serves to illuminate such issues. Hence, it is expected that much use will be made of descriptive data (summaries of curriculum analyses, reviews of curriculum change, performance on criterion-referenced items, reports on classroom practices, and so on). Item sampling will be used to provide a maximum of information, such as when comparing performance on benchmark items from the 1964 study.

A. Populations:

The survey will address two international populations defined as follows:

Population A. (Population I in first survey)

All students in the grade level where the majority of the students of age 13.00 - 13.11 are found.

Population B. (Population III in first survey)

All students who are in the normally accepted terminal grade of a secondary education system.

This population will be divided into two parts:

Population B1. Those studying mathematics as an intergral part of their course for future training.

Population B2. Those not studying mathematics or studying mathematics as a very minor element of their course.

In all cases the National Centers will be asked to specify these populations in terms of their own national systems and these specifications will need the endorsement of the International Mathematics Committee before the sampling procedures are undertaken.

B. Sampling

The aim will be to draw random, national, probability samples for each population. Although the details of the sampling plan will be determined in consultation with sampling experts, the design of the study calls for random sampling of schools and a minimum of two classes within the school at Population A. For Population B there appears to be major organizational difficulties if class groups were sampled. The samples will therfore be drawn from the students in relevent populations in a manner which keeps the standard errors as low as possible. Normally the sampling frame for each country will need to take account of school size; school type and location. In some countries it is recognized that sampling may have to be in three stages e.g., the United States would probably have to draw regions before drawing schools and students.

C. Data Collection

The responsibility for data collection belongs to the National Centers. However, the International Coordinating Center will produce a manual for the guidance of National Technical Officers, school coordinators, and test administrators. The format for these manuals will be similar to those used in the IEA Six Subject Survey and will provide detailed explanations of the administration of the project.

IEA will establish an international data processing unit, preferable alongside the coordinating center for the project.. Countries will send their data to the data processing unit in the form of tape records or marked response cards. Prior to the data collection code books will be advised to match the data.

D. Data Analysis

Any final global methodology and model of analysis will have to be compatable with issued identified earlier in this paper. It is clear though that programs for conventional Rasch model item analyses will be required. Factor analyses will play a large part in the valadatun of the descriptive and attitudinal scales. Univariate and correlational statistics will be of prime interest in elucidating many issues identified. Regression models will be used where appropriate but will not necessarily be the dominate mode of analysis as in previous IEA surveys.

It is also clear that a variety of overlaying methodologies from a pure research perspective are possible. While the general concern for IEA in this study will be only in addressing the identified issues; there is a responsibility for the International Mathematics Committee to ensure that the variables in their final form are ameneable to as many models of analysis as possible. To this end it is proposed that at an appropriate point the IMC would meet with a small group of people aware of this problem.

E. Organization of IEA

The New Zealand IEA National Center has the full responsibility for the

coordination and administration of the second mathematics survey. The New Zealand IEA Council Member and former Executive Director of IEA, Mr. Roy W. Phillipps, has been appointed by the IEA Council as the International Coordinator of the project. The New Zealand Department of Education has approved the establishment of a small coordinating unit consisting of a technical officer, research officer, seconded teacher and a clerical assistant, together with the international coordinator. In addition, the normal administrative and research and data processing services of the Department would be available to Mr. Phillipps. Further professional and technical assistance is available to the unit from the New Zealand Council for Educational Research which is also willing to act as the financial adminstrators for the project. The same offer is available from the Department of Education, but it would appear that their procedures may be more cumbersome.

The overhead costs within New Zealand for the activities of the coordinating center would be carried by the New Zealand Department of Education. There will, however, be certain international costs such as cables and toll calls which will not be able to be fully covered by New Zealand. In general, the policy of IEA is to have the international costs of the project shared by the participating countries. It is however difficult for many countries to make a direct international contribution. Many countries can contribute indirectly be purchasing master instruments or hosting meetings as was done by the IEA Scottish National Center at the recent St. Andrews meeting.

Each country participating will be represented by a National Center of IEA and in most cases it will be the National Center which is responsible for national administration. In some countries though it may be necessary to establish a coordinating center outside of the formal national center. The United States is a case in point. The research design and conduct of the survey will be in the hands of an IEA International Mathematics Committee set up by IEA. The

Committee will contain a balance of mathematicians, mathematics educators and survey experts. Initially the committee will be kept to the following six people:

Professor Kenneth Travers (Chairman), University of Illinois

Professor James Wilson, University of Georgia

Dr. Hans Steiner, University of Bielefeld

Dr. Sven Hilding, Ministry of Education, Stockholm

Dr. Edward Kifer, University of Kentucky

Mr. Gerald Pollock, Scottish Council for Research in Education

APPENDIX A

LIST OF VARIABLES

1. Introduction

As has been emphasized at several places in this bulletin, the thrust of the second study is in directions of primary interest to mathematics educators: those persons influential in developing curriculums for the nation's schools, those involved in identifying needed areas of research for improving the mathematical education of children, those responsible for the training of teachers of mathematics, those administering mathematics programs and finally, and perhaps most importantly, those who teach mathematics. Therefore, the variables which have been identified have focussed, as far as it seemed practicable, on classroom practice. Though reliable information in this area is, on the one hand, difficult to obtain, it is recognized that this sort of information is most likely to be of interest to those persons involved with improving classroom practice. Secondly, the variables identified for inclusion in the study are those having international importance. It is expected that each National Committee will identify other issues, and hence, additional variables, as national options, be of importance in their country. Efforts have been made to keep the total number of variables as small as possible. The problems of time constraints in schools, the perceived sensitivity of some kinds of data, and the relevance of the sought for information to the improvement of education have all been taken into account as the variables were specified.

At this preliminary stage, the International Committee on Mathematics depends very much upon input from the National Committees concerning all aspects of the proposed study. But we especially seek their assistance in identifying and specifying variables to be used. Such assistance is delineated in Working Paper VI, but it includes among other things, an assessment of the importance of the variable, an interpretation of meaning of the variable in their own

countries, and an indication of the case of obtaining the desired information in view of policies, or other factors which may bear upon collecting the desired data.

2. Sources of data:

a) National

In each country, the National Committee will be asked to provide a broad range of information on mathematics education from the national perspective.

b) School

For each school, a school administrator will be asked to fill out a questionnaire designed to provide certain basic information about the type of school, the nature of the educational program in the school, school practices, and personnel and financial information as it related to the mathematics program in that school.

c) Teacher

In each school, selected teachers will be asked to respond to a questionnaire designed to provide the IEA with information concerning their training and experience, their views about teaching, and their perception of the mathematics classroom. In addition, teachers will be asked to assist IEA in assessing the extent to which certain mathematics topics have been taught in their classrooms.

d) Student

i) Tests of mathematics achievement.

Each student in the IEA sample will be asked to attempt to answer mathematics achievemnt test questions. A pre-test requiring about 45 minutes will be given early in the school year and a post-test requiring about 90 minutes (two 45 minute sessions) will be given toward the close of the school year.

ii) Attitudes and Opinions.

Each student will be asked to respond to a questionnaire which is designed to provide information of the following sort: personal data (age, grade, sex, etc.); attitudes about mathematics; views about mathematics learning; and personal goals.

3. List of Variables

The variables for the Second Mathematics Survey, provided by the instruments indicated in 2 above, include those listed below.

The issue to which each of the variables bears importance is indicated, using the following key for issues:

A. The mathematics curriculum

1. The nature of the curriculum
2. The role of mathematical applications
3. Minimal mathematical competencies

B. Classroom Processes

1. Teaching strategies
2. Exposure to instruction

C. Changes in mathematics education since 1964

1. Benchmark comparisons
2. Sex differences
3. Uses of hand-held calculators
4. Conversion to SI measurement (International Option)

TEACHER VARIABLES

Number	Variable Name	Issues								
		Curriculum			Classroom Processes		Comparisons		
		A1	A2	A3	B1	B2	C1	C2	C3
1.	Teacher ID							x	
2.	Sex				x				
3.	Age				x				
4.	Mathematics major?				x				
5.	Credits beyond baccalaureate				x				
6.	Credits in college mathematics				x				
7.	Credits in teaching mathematics				x				
8.	Courses since last degree				x				
9.	Other types of preparation				x				
10.	Teaching load: hours				x	x			
11.	Teaching load: students				x				
12.	Total years experience				x				
13.	Experience at present school								
14.	Amount of class preparation				x				
15.	Hours marking papers				x				
16.	Member of mathematics teachers group				x				
17.	Engage in professional reading								

SCHOOL VARIABLES

Number	Variable Name	Issues								
		Curriculum			Classroom Processes		Comparisons			
		A1	A2	A3	B1	B2	C1	C2	C3	C4
1.	Name of school									
2.	Type of community served					x				
3.	Total enrollment, boys							x		
4.	Total enrollment, girls							x		
5.	Lowest school grade				x					
6.	Highest school grade				x					
7.	Age range in school				x					
8.	Enrollment in Population A									
9.	Enrollment in Population B									
10.	School sex type in Population A							x		
11.	School sex type in Population B							x		
12.	Day or boarding school									
13.	Availability of computers								x	
14.	Student access to computers								x	
15.	Decision making in school				x					
16.	Determiners of mathematics curriculum	x								
17.	Determiners of mathematics teaching methods				x					

SCHOOL VARIABLES

Number	Variable Name	Issues								
		Curriculum			Classroom Processes		Comparisons			
		A1	A2	A3	B1	B2	C1	C2	C3	C4
18.	Frequency of visits by outside officials				x					
19.	Purposes of visits by outside officials				x					
20.	Provision for operating costs				x					
21.	Annual budget				x					
22.	Percentage of budget allocated to mathematics	x						x		
23.	Number of full-time teachers							x		
24.	Percentage of teacher female				x					
25.	Percentage of teachers in mathematics							x		
26.	Percentage of mathematics teachers female									
27.	Type of program offered	x								
28.	Type of courses offered	x								
29.	Provision for remedial mathematics teaching				x					
30.	Weeks in school year					x				
31.	Total hours of instruction per week					x				
32.	Hours of mathematics instruction per week					x				
33.	Average daily percentage of attendance								x	
34.	Use of hand-held calculators									

SCHOOL VARIABLES

Number	Variable Name	Issues								
		Curriculum			Classroom Processes		Comparisons			
		A1	A2	A3	B1	B2	C1	C2	C3	C4
35.	Reason for non-use of calculators								x	
36.	Reason for introducing calculators								x	
37.	Extent of usage of calculators								x	
38.	Mathematics supervisor	x			x					
39.	Extent of in-service training				x					
40.	Years of mathematics available for majors									
41.	Mathematics available for non-majors	x								
42.	Years of mathematics required	x								
43.	Proportion ninth grade in college-prep math					x				
44.	Proportion of twelfth grade in college-prep math					x				

STUDENT VARIABLES

Number	Variable Name	Issues									
		Curriculum			Classroom Processes			Comparisons			
		A1	A2	A3	B1	B2	C1	C2	C3	C4	
1.	School										
2.	Student										
3.	Grade	x			x						
4.	Sex							x			
5.	Age	x	x	x	x	x	x	x	x	x	
6.	School/course program	x	x	x	x	x	x				
7.	Teacher(s) name				x			x	x		
8.	Number of students in class				x				x		
9.	Periods/lessons in mathematics					x					
10.	Number of hours of mathematics					x					
11.	Hours of schooling					x					
12.	Outside classes in mathematics					x					
13.	Mathematics homework					x					
14.	Father's education										
15.	Mother's education										
16.	Father's occupation										
17.	Mother's occupation										

STUDENT VARIABLES

Number	Variable Name	Issues								
		Curriculum			Classroom Processes		Comparisons			
		A1	A2	A3	B1	B2	C1	C2	C3	C4
18.	Years of full-time education expected						x	x		
19.	Years of full-time education desired						x	x		
20.	Expected occupation						x	x		
21.	Wished-for occupation						x	x		
22.	Wishes to take more mathematics					x	x	x		
23.	Extra activities in mathematics					x	x	x		
24.	Number of years of mathematics studied						x	x		
25.	Subjects liked most						x	x		
26.	Subjects liked least						x	x		
27.	Best achieved subjects						x	x		
28.	Worst achieved subjects				x	x				
29.	Allocation of class time								x	
30.	Use of computer								x	
31.	Use of pocket calculator									

APPENDIX B

Tentative Timetable

This timetable is based on the following assumptions:

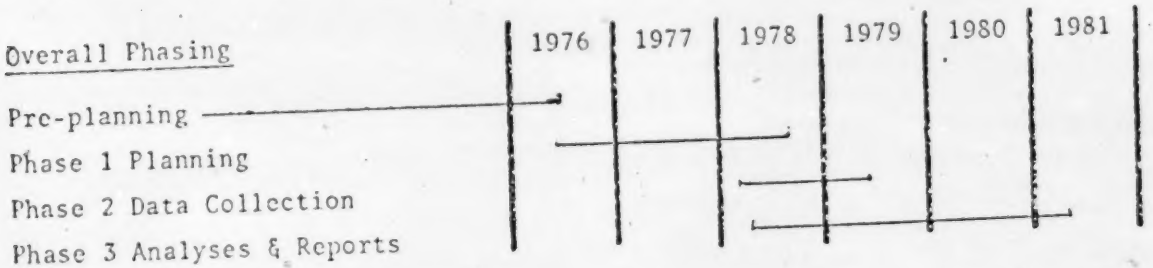
1. Most countries will administer a pretest approximately 10 months ahead of the main data collection.

2. International funding will be available to enable meetings of the International Mathematics Committee, National Technical Officers and Methodology consultants to be held.

3. The project will have three phases - Phase 1 will run for two years starting in July 1976, Phase 2, a data collection phase of approximately two years and Phase 3 the analyses and reporting. As the phases overlap to some extent the project should be complete by early 1981.

4. International Committee meetings will be held at appropriate times throughout the project.

Overall Phasing



PHASE 1

Tasks and Schedule

Curriculum Analysis	Start	Complete
Preliminary curriculum analysis and international grid	October 1975	August 1976
National responses to grid	September 1976	December 1976
International Mathematics Committee meeting		February 1976
Validation of National responses and follow-up missing data	February 1976	June 1976
Draft and critique international curriculum report	June 1976	December 1976

	Start	Complete
Final manuscript	December 1977	February 1978
Publish Report	February 1978	June 1978
Cognitive Instrument Construction		
Settle rationale, identify issues and grid	May 1976	September 1976
Refine test specifications	September 1976	February 1977
Gather National responses	September 1976	December 1976
Karlsruhe subcommittee		August 1976
Urbana subcommittee		September 1976
International Committee	January 1977	February 1977
Collect and write items	September 1976	February 1977
Develop pilot forms and manual for pretesting	January 1977	March 1977
Pretesting pilot forms and item analysis	March 1977	July 1977
Rasch model analysis (first survey)	June 1977	July 1977
International Committee	June 1977	July 1977
Pretest finalised and manuals written	July 1977	August 1977
Finalise cognitive instruments	July 1977	January 1978
National rating of items	January 1978	May 1978
Translation and administration of pretest - southern hemisphere	September 1977	February 1978
Translation and administration	September 1977	August 1978

	Start	Complete
Translation and administration of main tests.	February 1978	June 1979
Questionnaires and Attitudinal Scales Construction		
Rationale and issues identified	May 1976	September 1976
Identify attitudinal scales and develop draft instruments	May 1976	September 1976
Pre-pilot testing of scales with NAEP	October 1976	January 1977
Pilot development of opportunity-to-learn measure	September 1976	January 1977
National pretesting and analysis	March 1977	July 1977
International meeting	June 1977	July 1977
Draft questionnaires	June 1976	February 1977
Pretesting and critique of responses (questionnaire)	March 1977	July 1977
Finalise questionnaires and attitude scales	July 1977	January 1978
Translation and administration of final instruments	February 1978	June 1979
Preparation for Data Collection		
Identify modes of analysis for all variables	June 1976	February 1977
Establish over-riding methodology for all data	February 1977	July 1977

	Start	Complete
International Committee consult with methodology experts	February 1977	July 1977
National Technical Officers meet	June 1977	July 1977
Sampling consultation and a draft of master sampling plan	September 1976	February 1977
Critique of sampling plan	February 1977	April 1977
Settle sampling plan	June 1977	July 1977
Reanalysis of first survey data	August 1976	July 1977
National sampling plans referred	July 1977	September 1977
Samples drawn, contact schools and replace refusals	September 1977	May 1978
Codebooks drafted and revised	February 1977	February 1978
Design and produce answer cards	September 1977	May 1978
Develop manuals for test administration	October 1977	May 1978
Train school co-ordinators and distribution of pretest materials	August 1977	May 1978
Train school co-ordinators and distribute main test materials	May 1978	March 1979

PHASE 2

	Start	Complete
Administer Pretest	February 1978	August 1978
National Technical Officers report on pretesting	March 1978	September 1978
Dry run and revision of procedures	May 1978	January 1979

	Start	Complete
Test analysis programs and update codebooks	August 1978	April 1979
Main data collection	October 1978	June 1979
Check returns and follow up missing data	November 1978	July 1979
National Technical Officers reports	December 1978	July 1979
PHASE 3		
Analysis of pretest data	March 1978	November 1978
Create raw data files	December 1978	September 1979
Edit and score data	February 1979	December 1979
Produce univariates and item analyses	March 1979	February 1980
Multivariate analyses	April 1979	May 1980
Draft National reports	October 1979	July 1980
Draft International report	October 1979	August 1980
Preparation of Data Bank	February 1979	December 1980
Final manuscript	September 1980	December 1980
Publish report	January 1981	March 1981